

CLAIMS

What is claimed is:

1 1. A circuit, comprising:
2 a capacitor coupled to be alternately charged and discharged by first and
3 second current sources;
4 a first voltage follower circuit including a first bipolar transistor having a
5 base coupled to the capacitor, the first bipolar transistor biased such that a voltage
6 at an emitter of the first bipolar transistor follows a voltage on the capacitor; and
7 a current mirror having first and second current paths, the first current path
8 coupled to the base of the first bipolar transistor, the first current path providing
9 substantially all of a base current received by the base of the first bipolar
10 transistor.

1 2. The circuit of claim 1 wherein the base current received by the base
2 of the first bipolar transistor includes substantially zero current received from the
3 capacitor.

1 3. The circuit of claim 1 further comprising a second voltage follower
2 circuit including a second bipolar transistor having a base coupled to the second
3 current path, the second current path providing substantially all of a base current
4 received by the base of the second bipolar transistor.

1 4. The circuit of claim 3 wherein the first and second bipolar
2 transistors are substantially matched in current density.

1 5. The circuit of claim 3 further comprising first and second bias
2 current sources, the first bias current source coupled to the emitter of the first
3 bipolar transistor and the second bias current source coupled to an emitter of the
4 second bipolar transistor.

1 6. The circuit of claim 1 further comprising a switch coupled between
2 the second current source and the capacitor, the switch coupled to be
3 alternately opened and closed such that when the switch is opened, the first
4 current source is coupled to charge the capacitor and when the switch is closed,
5 the first and second current sources are coupled to discharge the capacitor.

1 7. The circuit of claim 6 wherein the switch is coupled to be opened
2 until the voltage on the capacitor is charged to a first threshold and wherein the
3 switch is coupled to be closed until the voltage on the capacitor is discharged to a
4 second threshold.

1 8. The circuit of claim 7 further comprising a comparator coupled to
2 receive the voltage at the emitter of the first bipolar transistor, an output of the
3 comparator coupled to control the switch.

1 9. The circuit of claim 1 wherein a ratio of currents provided by the
2 first and second current sources is substantially fixed to provide a substantially
3 fixed duty ratio of an oscillating voltage provided on the capacitor.

1 10. The circuit of claim 1 wherein a ratio of currents provided by the
2 first and second current sources is variable to adjust a duty ratio of an oscillating
3 voltage provided on the capacitor.

1 11. The circuit of claim 1 wherein magnitudes of currents provided by
2 the first and second current sources are substantially fixed to provide a
3 substantially fixed frequency of an oscillating voltage provided on the capacitor

1 12. The circuit of claim 1 wherein magnitudes of currents provided by
2 the first and second current sources are variable to adjust a frequency of an
3 oscillating voltage provided on the capacitor.

1 13. An integrated circuit, comprising:

2 a capacitor coupled to a first current source and to a switch, the switch
3 coupled to a second current source, a magnitude and a direction of the first current
4 source and the second current source causing a voltage on the capacitor to change
5 in one direction when the switch is open and to change in an opposite direction
6 when the switch is closed;

7 a voltage follower circuit including an input coupled to the capacitor;

8 a comparator circuit having an input coupled to an output of the voltage
9 follower circuit, an output of the comparator circuit coupled to the switch such
10 that the switch is opened when the voltage on the capacitor reaches a first
11 threshold and the switch is closed when the voltage on the capacitor reaches a
12 second threshold;

13 a first bipolar transistor included in the voltage follower circuit, the first
14 bipolar transistor having an emitter coupled to a third current source, a base of the
15 first bipolar transistor coupled to the capacitor;

16 a second bipolar transistor substantially the same as the first bipolar
17 transistor, an emitter of the second bipolar transistor coupled to a fourth current
18 source, the fourth current source substantially the same as the third current source;
19 and

20 a current mirror circuit coupled to a base of the second bipolar transistor
21 such that an output current of the current mirror circuit is substantially equal to a
22 base current of the second bipolar transistor, the output current of the current
23 mirror circuit coupled to the base of the first bipolar transistor.

1 14. The integrated circuit of claim 13 wherein the integrated circuit is
2 included in a controller in a switching power supply.

1 15. The integrated circuit of claim 13 wherein the magnitude of the
2 first current source and the magnitude of the second current source are
3 substantially constant while the voltage on the capacitor is changing.

1 16. The integrated circuit of claim 13 wherein the magnitude of the
2 first current source and the magnitude of the second current source are
3 proportional with a ratio that is substantially constant while the voltage on the
4 capacitor is changing.

1 17. The integrated circuit of claim 13 wherein the magnitude of the
2 first current source and the magnitude of the second current source are variable.

1 18. An integrated circuit oscillator comprising
2 a capacitor coupled to a first current source and a second current source,
3 magnitudes and directions of the first current source and the second current
4 source, respectively, causing a voltage on the capacitor to change in one direction
5 until the voltage on the capacitor reaches a first threshold and to change in the
6 opposite direction when the voltage on the capacitor reaches a second threshold;

7 a first bipolar transistor having a base coupled to the capacitor;
8 a second bipolar transistor having a current density substantially equal to a
9 current density of the first bipolar transistor;
10 a current mirror circuit coupled to a base of the second bipolar transistor,
11 the current mirror circuit having an output substantially proportional to a base
12 current of the second bipolar transistor, wherein the output of the current mirror
13 circuit is substantially equal to a base current of the first bipolar transistor,
14 wherein the output of the current mirror circuit is coupled to the base of the first
15 bipolar transistor.

1 19. The integrated circuit of claim 18 wherein the integrated circuit is
2 included in a controller in a switching power supply.

1 20. The integrated circuit of claim 18 wherein the magnitude of the
2 first current source and the magnitude of the second current source are
3 substantially constant while the voltage on the capacitor is changing.

1 21. The integrated circuit of claim 18 wherein the magnitude of the
2 first current source and the magnitude of the second current source are
3 proportional with a ratio that is substantially constant while the voltage on the
4 capacitor is changing.

- 1 22. The integrated circuit of claim 18 wherein the magnitude of the
2 first current source and the magnitude of the second current source are variable.